

Syllabus for M.Sc. Zoology 2018-19

P.G. Department of Zoology
Khalsa College Amritsar

Scheme of Course

Semester-I

<i>Course No.</i>	<i>Title</i>	<i>Periods/week</i>	<i>Marks</i>	<i>Page</i>
ZooC- 501	Functional Organization of Animals – I	8	100	3
ZooC- 502	Animal Ecology	8	100	5
ZooC- 503	Cell Biology	8	100	7
ZooC- 504	Computer Programming & Data Processing	4	50	9
ZooC-551	Practical- I (F.O.A. -I)	4	50	10
ZooC-552	Practical- II (Ecology &Cell Biology)	4	50	11
Total			450	

Semester-II

<i>Course No.</i>	<i>Title</i>	<i>Periods/week</i>	<i>Marks</i>	<i>Page</i>
ZooC-601	Functional Organization of Animals- II	8	100	12
ZooC-602	Applied Zoology I (Invertebrates)	6	75	14
ZooC-603	Evolution	4	50	17
ZooC-604	Seminar	2xN*	50	19
ZooC-605	Biostatistics	6	50	20
ZooC-651	(Practical- III F.O.A.-II)	4	50	21
ZooC-652	Practical-IV(Evolution & Applied Zoology-I)	4	50	22
Total			425	

*N-represents number of teachers

Semester-III

<i>Course No.</i>	<i>Title</i>	<i>Periods/week</i>	<i>Marks</i>	<i>Page</i>
ZooC- 701	Research Techniques	8	100	23
ZooC- 702	Developmental Biology	8	100	25
ZooC- 703	General Biochemistry	8	100	27
ZooC- 704	Applied Zoology-II (Vertebrates)	6	75	29
ZooC- 751	Practical -V (F.O.A.-III & Applied Zool. II)	4	50	31
ZooC-752	Practical VI (Developmental Biology &Biochemistry)	4	50	32
Total			475	

Semester-IV

<i>Course No.</i>	<i>Title</i>	<i>Periods/week</i>	<i>Marks</i>	<i>Page</i>
ZooC- 801	Animal Behaviour and Wildlife conservation	8	100	33
ZooC- 802	Animal Genetics & Biotechnology	8	100	35
ZooC- 803	Concepts of Immunology	8	100	37
ZooC- 804	Biosystematics	4	50	39
ZooC- 851	Practical -VII (Behaviour and Wildlife)	4	50	41
ZooC- 852	Practical VIII (Genetics & Biosystematics)	4	50	42
Total			450	

Semester-I

ZooC-501: FUNCTIONAL ORGANIZATION OF ANIMALS- I

Examination Time: 3 hrs.

Periods/Week: 8

Theory:75

Internal Assessment:25

Total Marks:100

Instructions to the Paper setters:

The question paper will be divided into 2 sections.

Section A: (Total weightage 15 marks). This section will have 10 very short answer type questions. All questions will be compulsory. Each question will carry 1.5 marks. Questions are to cover the whole of syllabus.

Section B: (Total weightage 60 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 15 marks and its answers should not exceed 6 pages. The questions should not have more than two subparts.

Unit –I

- **Nutrition & Digestion**

- Ingestion of soluble food and particulate food in relation to habitat and habits.
- Symbiotic nutrition.
- Mechanism of digestion and regulation of secretion in non-chordates and chordates.

Unit – II

- **Transport and Circulatory mechanisms**

- Intracellular transport in Protozoa.
- Circulation of external medium of transport within the body of sponges and cnidarians.
- Open and closed types of circulatory system.
- Chambered, tubular and ampullary hearts, neurogenic and myogenic hearts
- Evolution of Heart and Cardiovascular system

Unit–III

- **Respiratory System:**

- Respiratory organs in aquatic animals and aquatic respiration.
- Respiratory organs and aerial mode of respiration.
- Distribution and brief chemistry of respiratory pigments and their function in non-chordates and chordates.

- **Reproduction**

- Pattern of reproduction in non-chordates and larval forms.
- Evolution of the urino-genital system in chordates with special reference to the separation of the two systems.

Unit – IV

• Osmoregulation and Excretion

- Osmoconformers and osmoregulators, hyper-, hypo- and iso-osmotic mediums.
- Excretion and metabolic waste products – an introduction.
- Excretory structures and waste disposal in non-chordates, coelom, coelomic ducts, nephridia, antennal / green glands, malpighian tubules.
- Osmoregulation in non-chordates, adaptation to different environments / habitats.
- Development and adult structural organization of chordate kidney: nephron, the functional unit.

Suggested Reading Material:

1. Barrington, E. U. W. (1967), Invertebrates Structure and Functions. Houghton Mifflin Co. Boston.
2. Barth, R. H. and Broshears, R. E (1982), The Invertebrate world. Holt Saunder, Japan.
3. Brusca, R. C. and Brusca, G. J. (2003), Invertebrates second edition. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts.
4. Gardiner, M. S. (1972), The Biology of Invertebrates, McGraw Hill, New York.
5. Hill, R. W., Wyse, G. K. and Anderson, N. (2004), Animal physiology. Sinauer Associate, INC. Pub. Saunderland, Massachusettes, USA.
6. Hoar, W. S. (1984), General and Comparative Physiology. Prentice Hall of India Pvt. Limited, New Delhi, India.
7. Karp, G.(2005), Cell and Molecular Biology; concepts and experiments (4th ed.),Hoboken, John Willy and Sons, New York.
8. Meglitsch, P. A. and Schran, F. R. (1991), Invertebrate Zoology 3rd Ed. Oxford University Press, New York.
9. Prosser, C.L. (1984), Comparative Animal Physiology. Satish Book Enterprise Books seller & Publishers, Agra.
10. Randall, D., Burggren, K.L. and French, K. (2002), Eckert Animal Physiology: Mechanisms and Adaptations. W.H. Freeman and Company, New York.
11. Ruppert, E. E. and Barnes, R. D. (2004), Invertebrate Zoology 7th ed. Saunders Publ., Philadelphia.
12. Withers, P.C. (1992), Comparative Animal Physiology Saunder College Publishing, New York.

Semester-I
ZooC– 502: ANIMAL ECOLOGY

Examination Time: 3 hrs.
Periods/Week: 8

Theory: 75
Internal Assessment: 25
Total Marks: 100

Instructions to the Paper setters:

The question paper will be divided into 2 sections.

Section A: (Total weightage 15 marks). This section will have 10 very short answer type questions. All questions will be compulsory. Each question will carry 1.5 marks. Questions are to cover the whole of syllabus.

Section B: (Total weightage 60 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 15 marks and its answers should not exceed 6 pages. The questions should not have more than two subparts.

Unit – I

- **Introduction and History of Ecology**
 - Structure and Functions of some special types of ecosystems (Grasslands, forests, deserts and aquatic ecosystems).
- **Weather**
 - Temperature, Moisture, Light, fire, Malentite, pollution

Unit – II

- **Analysis of Environment**
 - Resource
 - Food, its distribution, relative and absolute shortages
 - Place in which to live
- **Community Structure**
 - Ecological Niche, Food chains, Food webs, biomagnifications, succession / temporal changes.
- **Interactions and Coactions**
 - Between animals of same kind
 - Between animals of different kind
 - Predation, Parasitism, Commensalism, Mutualism etc.

Unit- III

- **Adaptations**
 - Cave, deep sea, arboreal, aerial, and sub terrestrial.
 - Co-adaptations and adaptive resemblances (mimicry, warning colouration, seasonal polymorphism)
- **Population Ecology**
 - Concept of Population

- Biotic potential and carrying capacity, dispersal and distribution, population growth and its regulations.
- **Methods of sampling**
 - Life tables and longevity
 - Migration and Ecesis

Unit – IV

- **Applied Ecology**
 - Anthropogenic interferences
 - Bio monitoring of environment using animal species
 - Modeling and Use of remote sensing (GIS) in ecology (introduction)
 - Ecological basis of pest regulation (in brief)
- **Bio Geography**
 - Zoo Geographical regions
 - Island ecology (endemicity)

Suggested Reading Material:

1. Anderwartha, H.G. and Birch, L. C. (1970), The distribution and abundance of animals, University of Chicago Press, Chicago London.
2. Beeby, A. (1992), Applying Ecology Chapman and Hall Madras.
3. Begon, M., Harper J. L. and Townsend, C. R. (1995), Ecology – Individuals, populations and communities, Blackwell Science, Cambridge UK.
4. Brewer, R. (1994), The science of Ecology, Saunders College of Publishing, New York.
5. Chapman, J. L. and Resis, M. J. (1995), Ecology- Principles and applications, Cambridge University Press, Cambridge UK.
6. Kaeighs, S. C. (1974), Ecology with special references to animal and Man, Prentice Hall Inc.
7. Odum, E. P. (1983), Basic Ecology.
8. Putmann, R. J. and Wratten, S. D. (1984), Principles of Ecology, Crown Helm, London.
9. Salanki, J., Jeffery E. and Hughes G. M. (1994), Biological Monitoring of the Environment (A manual of Methods) CAB International, Wallingford UK.

Semester-I
ZooC-503: CELL BIOLOGY

Examination Time: 3 hrs.
Periods/Week: 8

Theory: 75
Internal Assessment: 25
Total Marks: 100

Instructions to the Paper setters:

The question paper will be divided into 2 sections.

Section A: (Total weightage 15 marks). This section will have 10 very short answer type questions. All questions will be compulsory. Each question will carry 1.5 marks. Questions are to cover the whole of syllabus.

Section B: (Total weightage 60 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 15 marks and its answers should not exceed 6 pages. The questions should not have more than two subparts.

Unit-I

- **Introduction**
 - Cell – a unit of structure and function, cell theory.
 - General Properties of the Cell, Size, shape, number, life span and death.
 - Cell types: Prokaryotes and eukaryotes, Stem cells.
- **Organization of Prokaryote Cell**
 - Mycoplasma, Bacteria, Cyanobacteria (Blue Green Algae). Structure and importance of their study.
- **From Prokaryotes to Eukaryotes**
 - Events leading to origin of eukaryotic cells. Endo symbiotic theory & recent views.
- **Structure of Cell Membrane**
 - General properties of cell membrane, chemical composition.
 - The concept of unit membrane, Various Lipoprotein models including fluid mosaic model.

Unit – II

- **Golgi Complex**
 - Structure and Function of: Cisternae, vacuoles and vesicles,
 - Functions: Role in secretion, cell wall formation, packaging of intracellular products and other functions, GERL concept.
- **Mitochondria**
 - Elaboration of the plasma membrane and multi enzyme complex, outer and inner membranes, cristae, matrix, inner and outer compartments,
 - Location of enzyme complexes of TCA cycle (and ATP generation)
 - Electron transport chain, semi autonomous nature (mitochondrial DNA, RNA, ribosomes and protein synthesis)
- **Endoplasmic Reticulum**
 - Extension of cell membrane, cisternae, Site of location
 - Compartmentalization of enzymes and metabolites and their associated functions.

Unit – III

- **Ribosomes**
 - A complex of ribonucleoproteins

- Dynamics of association - disassociation of ribosomes into polysomes, microsomes, Site of protein synthesis (initiation, elongation, translocation and termination phases of protein synthesis), Central dogma.
 - **Lysosomes**
 - Polymorphic single membrane structure, site of proteolytic activity for intracellular digestion
 - Phagocytosis, increase in lysosomal activity with age, Lipofuscin pigments, diseases associated with lysosomes.
 - **Peroxisomes and Glyoxisomes**
 - Single membrane structure; site of enzyme complexes involved in hydrogen peroxide metabolism, gluconeogenesis (conversion of non carbohydrate into carbohydrates)
 - Glyoxylate pathway, microperoxisomes.
 - **Cytoskeleton:** Actin filament, Myosin, Intermediate filament, microtubules.
- Unit – IV**
- **Cell Surface Modifications:** Glycocalyx, villi, microvilli, caveolae.
 - **Cytoplasmic Inclusions**
 - Inert storage materials, glycogen, starch, lipids, metabolic crystals
 - **Nucleus**
 - Nuclear membrane, pores, chromatin, (euchromatin & heterochromatin), nucleolus,
 - Eukaryote chromosomes structure (DNA, Histone and other proteins, Nucleosome and solenoid concept).
 - Kinetochore, centromere and gene structure.
 - **Cell Continuity**
 - Phases of cell cycles
 - Mitosis and Meiosis

Suggested Reading Material:

1. Alberts, B. Bracy, P. Lewis, J. Raff, M. Roberts K and Watson, J. (eds.) (1994). Molecular Biology of the Cell, Garland Publishing , New York.
2. Avers, C. J. (1976). Cell Biology, Van Nostrand Reinhold, New York.
3. Cooper, G. M. (2004). The cell, A Molecular Approach ASM press, Washington, D. C.
4. Chandra Roy, S and DE Kumar, K. (2001) Cell Biology. New Central Book Agency (P) Ltd. Kolkata.
5. Darnell, J. Lodish, H. and Baltimore, D. (2004). Molecular Cell Biology, 2nd edition, Freeman, New York.
6. Derobertis, E. D. P. and Derobertis, E.M.F. (1987). Essentials of Cell and Molecular Biology. Hold Saunders – Philadelphia.
7. Hopkins, C. L. (1978). Structure and Functions of Cells . Saunders – Philadelphia.
8. Karp G. (1999). Cell and Molecular Biology. Concepts and Experiments, 2nd Editon John Wiley and Sons, Inc. New York, Brisbane, Toronto.
9. Powar, C. B. (1990). Cell Biology. Himalaya Publishing House, Bombay.
10. Sadava, D. E. (1993). Cell Biology – Organelle, Structure and Fucntions. H. Jones and Bartlett- Boston.
11. Smith & Wood (1992). Cell Biology, Chapman & Hall, London, New York.
12. Wolfe, S. L. (1983). Introduction of Cell Biology, Woodworth Belmont.

Semester-I
ZooC-504: COMPUTER PROGRAMMING & DATA PROCESSING

Time: 3 hrs.

Theory: 37
Internal Assessment: 13
Total Marks: 50

Instructions for the Paper-Setters:

Eight questions are to be set. Candidates are required to attempt any five. Each question carries equal marks

Unit – I

1. Introduction to computer capability, history and classification of computers.
2. Computer architecture, organization, its components, hardware and software concepts, operating systems, peripherals, I/O devices.
3. Introduction to programming Languages.

Unit – II

4. Problem solving through computers, flow chart systems and software development.
5. Personal Computers, characteristics, capabilities, application packages.
6. Word Processing and desktop publishing.
7. Limitations of computers.

Unit – III

8. Introduction to Basic syntax notation overview.
9. Program structure, elements, basic character set, constants, variables operators and expressions.
10. Basic Statements I/O statements. Edit statements, fill statements, declarative statements, remark statements, arrays.
11. Assignments and controls statements: ON GO TO, IF THEN, ELSE FOR NEXT, WHILE WEND, UNTIL NEXT.

Unit - IV

12. Subroutine functions.
13. Files, basic files organizations, file related statements and key-words.

Semester-I

ZooC-551: PRACTICAL –I (FUNCTIONAL ORGANIZATION OF ANIMALS-I)

Examination Time: 4 hrs.
Periods/Week: 4

Practical: 37
Internal Assessment: 13
Total Marks: 50

1. Study of permanent slides:-
 - Mouth parts: honey bee, housefly, cockroach, butterfly, mosquito, and bug.
 - Salivary glands.
 - Blood of animals.
 - Radula of Pila and jaws of Leech
2. Using slides/charts/models/videos study of following:-
 - **Anatomy of gut in relation to food and feeding habits** of detritivores, carnivores, herbivores, omnivores and sanguivores.
 - **Different kinds of Heart and blood vascular system in animals.**
 - **Respiratory structures:** Gills (Crustaceans, Bivalves, Cephalopods, and Fish); Book Lungs (Scorpion); Trachea and spiracles (Cockroach).
 - **Nephridia in annelids** (earthworm), green glands in crustaceans, Malpighian tubules in Cockroach.
 - **Excretory system** of frog, lizard, bird and rat.
 - **Histology** of ovary, oviduct, uterus, testis and placenta in different groups of invertebrates & vertebrates.
 - **Reproductive organs** in Hydra, Flatworm, Earthworm, Cockroach, Pila, Fish, Frog, Lizard, Bird and Rat.

Minor changes in practical syllabus can be there as per the availability of materials.

*Dissections should strictly be done in accordance with the UGC guidelines and after getting approved from the Dissection monitoring committee of the respective institution.

Semester-I

ZooC -552: PRACTICAL –II (ECOLOGY AND CELL BIOLOGY)

Examination Time: 4 hrs

Periods/Week: 4

Practical: 37

Internal Assessment: 13

Total Marks: 50

1. Population estimations: Using Mark and Release method and to study the effect of migration on them (Using Moong and Mash beans).
2. Estimation of population:
 - a. Insect population using sweep net method.
 - b. Protozoans
 - c. Nematodes
 - d. Soil arthropods
3. Combined population studies using quadrates.
4. To determine diversity indices (richness, Simpson, Shannon-Wiener).
5. Intrapopulation distribution and Poisson distribution, construction of life table and survivorship curves from given data.
6. Microscopy:
 - a. Principles of compound, phase contrast and electron microscopy.
 - b. Use and care of Light compound microscope.
 - c. Lens aberrations
7. Study of Cells: using permanent slides
 - a. Prokaryote cells: Lactobacillus, E. coli. Blue green algae.
 - b. Eukaryote cells, Testicular material (for studies of spermatogenesis).
8. Microtomy:
 - a. Introduction of the instrument – its use and care.
 - b. Preparation of permanent slides: Principles and procedures – Section cutting of tissues and staining of tissues with Haematoxylin/Eosin method.
9. Study of permanent slides of various tissues (gut region, liver, lung, spleen, kidney, pancreas, testis, ovary, tongue, skin etc.).
10. Cytochemical techniques: Study carbohydrates, nucleic acids, proteins, lipids and enzymes.
11. Study of electron micrographs of various cell organelles – plasma membrane, Mitochondria, Golgi complex, Lysosomes, Endoplasmic reticulum (smooth and granular), Cilia, Centrioles, inclusions like glycogen, lipids etc.

*Minor changes in practical syllabus can be there as per the availability of materials.

As per the latest UGC guidelines (D.O.No. F. 14-6/2014(CPP-II) dated 01-08-2014) the dissections should not be conducted. The guidelines on this issue are available on the UGC website:

www.ugc.ac.in

Semester-II

ZooC -601: FUNCTIONAL ORGANIZATION OF ANIMALS –II

Examination Time: 3 hrs.
Periods/Week: 8

Theory: 75
Internal Assessment: 25
Total Marks: 100

Instructions to the Paper setters:

The question paper will be divided into 2 sections.

Section A: (Total weightage 15 marks). This section will have 10 very short answer type questions. All questions will be compulsory. Each question will carry 1.5 marks. Questions are to cover the whole of syllabus.

Section B: (Total weightage 60 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 15 marks and its answers should not exceed 6 pages. The questions should not have more than two subparts.

Unit - I

- **Integumentary System**
 - Embryonic origin
 - General features of the Integument
 - Specializations of integument
 - Evolution of Skin
- **Muscular System**
 - Classification of Muscles, Structure of Skeletal Muscles and cardiac muscle, Tendons
 - Muscle mechanics
 - Muscle Function Basis of Muscles contraction,
 - Muscle Fiber, Muscle organs and fibers
 - Bone-muscle lever systems

Unit–II

- **Skeletal System**
 - Exo and Endo Skeleton in Invertebrates
 - Appendicular skeleton in vertebrates, Basic Components
 - Phylogeny of fishes and tetrapods
 - Evolution of the Appendicular system
 - Form and Function
 - Swimming
 - Terrestrial locomotion

Unit – III

- **Integratory Systems**
 - Chemical coordination of body functions through neuro-secretion in non-chordates.
 - Physiology of nerve net and giant fibre system.
 - Evolution of functional anatomy of brain.

- **Endocrine System**
 - Endocrine organs
 - Chemical coordination of body functions through hormones and neuro secretions

Unit-IV

- **Sensory System**
 - General sensory organs
 - Free sensory receptors
 - Encapsulated sensory receptors
 - Associated sensory receptors
 - Mechanisms of perceiving stimuli
 - Special sensory organs (Mechano, Radiation, Chemo and Electro-receptors)
 - Additional special sensory organ

Suggested Reading Material:

1. Barrington, E. U. W. (1967), Invertebrates Structure and Functions. Houghton Mifflin Co. Boston.
2. Brusca, R. C. and Brusca, G. J. (2003), Invertebrates Second Edition. Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts.
3. Cooper, G. M. (2004), The Cell: A Molecular Approach, IIIrd edition, ASM Press, Washington, D.C.
4. Engemann, J. G. and Hegner, R. W. (1981), Invertebrate Zoology (3rd ed.) Macmillan, New York.
5. Gardiner, M. S. (1972), The Biology of Invertebrates, McGraw Hill, New York.
6. Hill, R. W., Wyse, G. K. and Anderson, N. (2004), Animal Physiology. Sinauer Associate, INC. Pub. Saunderland, Massachusetts, USA.
7. Hoar, W. S. (1984), General and Comparative Physiology. Prentice Hall of India Pvt. Limited, New Delhi, India.
8. Karp, G.(2005), Cell and Molecular Biology; Concepts and Experiments (4th ed.), Hoboken, John Willy and Sons, New York.
9. Meglitsch, P. A. and Schran, F. R. (1991), Invertebrate Zoology 3rd Ed. Oxford University Press, New York.
10. Prosser, C.L. (1984), Comparative Animal Physiology. Satish Book Enterprise Books Seller & Publishers, Agra.
11. Randall, D., Burggren, K.L. and French, K. (2002), Eckert Animal Physiology: Mechanisms and Adaptations. W.H. Freeman and Company, New York.
12. Ruppert, E. E. and Barnes, R. D. (2004), Invertebrate Zoology 7th ed. Saunders Publ., Philadelphia.
13. Willmer, P. . Stone, G. and Johnston, I (2000). Environmental Physiology of Animals, Blackwell Science.
14. Withers, P.C. (1992), Comparative Animal Physiology Saunder College Publishing, New York.

Semester-II
ZooC -602: APPLIED ZOOLOGY- I (INVERTEBRATES)

Examination Time: 3hrs.
Periods/Week: 6

Theory: 56
Internal Assessment: 19
Total Marks: 75

Instructions to the Paper setters:

The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 6 very short answer type questions. All questions will be compulsory. Each question will carry 2 marks. Questions are to cover the whole of syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 6 pages. The questions should not have more than two subparts.

Unit – I

- **Arthropods (Important Species and their Economic Importance)**
 - Diplopods and Chilopods
 - Arachnids (other than plant pests)
 - Insects (other than insect pests of crops, parasite of man and domestic animals)
 - As pollinators
 - In Biological pest management
 - As source of food
 - Venomous insects
- **Apiculture**
 - History and Introduction
 - Honey bee and kinds
 - Social organization and colony nests
 - Life Cycle
 - Relation between honeybees and plants
 - Flora for Apiculture
 - Honey composition, quality and importance
 - Bee keeping, selection, methods, precautions
 - Products of bee keeping
 - Bee enemies and diseases

Unit – II

- **Lac culture**
 - Introduction
 - Lac insects: species, Life cycle and Host plants
 - Lac composition, properties & importance

- Cultivation and Harvesting of Lac
- Enemies of Lac insect and host plants
- Lac industry in India
- **Sericulture**
 - Indian sericulture in industry distribution and prospects
 - Silkworm moth species and their Life Cycle
 - Silk composition, kinds and uses
 - Mulberry cultivation
 - Rearing of silkworm
 - Treatment and disposal of cocoons
 - Silk reeling, twisting and weaving
 - Diseases & pests of silkworm

Unit – III

- **Crustaceans (Important species and their Economic Importance)**
 - Crab, lobsters, copepods.
- **Prawn Culture**
 - Introduction to prawns
 - Prawn: species
 - Fresh water prawn farming and Marine Prawn farming
 - Methods of Prawn farming.
 - Spoilage and its prevention.
 - Processing and preservation of prawns.
 - Future of prawn culture
- **Molluscs (Economically important species)**
 - Eulamellibranchs
 - Gastropods
 - Cephalopods
- **Pearl Culture**
 - Pearl culture, Historical background
 - Pearl oyster –species
 - Pearl formation, composition, quality and commercial value
 - Artificial culturing, synthetic pearls types and their manufacturing.
 - Methods of harvesting
 - Problems of pearl industry

Unit – IV

- **Economic Importance of :-**
 - Protozoans
 - Important Parasitic species, diseases caused, prevention and cure.
 - Annelids

- Leeches
- **Vermiculture**
 - Species of worms, condition for efficient vermiculture (domestic and commercial level),
 - Economics of Vermiculture
- **Helminthes ((Important species and their Economic Importance)**
 - Liver flukes
 - Cestodes/ tapeworms
 - Roundworms (Animal and plant parasitic Nematodes)
 - Echnioderms (Important species and their Economic Importance) :Sea cucumbers, Star Fish

Suggested Reading Material

1. Bhamrah, H. S. & Juneja, K. (2001), An Introduction to Mollusca. Anmol Publications Pvt., Ltd. New Delhi.
2. Bhatnagar, R. K. and Palta, R. K. (2003), Earthworm ; Vermiculture and Vermicomposting , Kalyani Publishers India.
3. Carter, G. A. (2004) Beekeeping , Biotech Books, New Delhi.
4. Fenemore, P. G. and Prakash, A. (1992), Applied Entomology, Wiley Eastern Ltd. New Delhi.
5. Ghorai, N. (1995), Lac Culture in India. International Books and Periodicals, New Delhi.
6. Jhingran , V. G. (1991) Fish and Fisheries of India, Hindustan Publishing Company India.
7. Kumar, A. and Nigam, P. M. (1989), Economic and Applied Entomology EMKAY Publishing Co. New Delhi.
8. Mishra, R. C. (1995), Honey Bees & their Management in India. ICAR, New Delhi.
9. Mustafa, S. (1990) Applied and Industrial Zoology. Associated Publishing Company, New Delhi.
10. Shukla, G. S. & Upadhaya, V. B. (1991-92), Economic Zoology, Rastogi Publications, Meerut.
11. Sathe, T. V. and Jadhav, A. D. (2001) Sericulture and Pest Management, Daya Publishing House, New Delhi.
12. Shimizu, M. (1972) Handbook of Silkworm Rearing (Agricultural Techniques Manual-1) Fuji Publishing Co. Ltd , Tokyo, Japan.
13. Singh, S. (1962), Bee Keeping in India, I. C. A. R. Publications, New Delhi.
14. Sobti, R. C. (1992), Medical Zoology, Nagin Chand & Co. Jalandhar.
15. Srivastava, P. A. (1977), Economic Zoology, Commercial Publication Bureau, Kanpur.
16. Ullal, S.R. and Narsimhanna, M. N. (1981), A Handbook of Practical Sericulture, Central Silk Board, Bombay.
17. Venkatanarasaiah, P. (1992), Sericulture in India, Ashish Publishing House, New Delhi.

Semester-II
ZooC -603: EVOLUTION

Examination Time: 3hrs.
Periods/Week: 4

Theory: 37
Internal Assessment: 13
Total Marks: 50

Instructions to the Paper setters:

The question paper will be divided into 2 sections.

Section A: (Total weightage 09 marks). This section will have 6 very short answer type questions. All questions will be compulsory. Each question will carry 1.5 marks. Questions are to cover the whole of syllabus.

Section B: (Total weightage 28 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 07 marks and its answers should not exceed 6 pages. The questions should not have more than two subparts.

Unit – I

- **Origin of Life**
 - Origin of Micro molecules
 - Origin of Macro molecules
 - Origin of Viruses
 - Origin of Genetic code
 - Origin of Prokaryotes
 - Origin of Unicellular eukaryotes and multicellularity
- **Organic Evolution**
 - Theories
 - Evidences
 - Separation of kingdoms

Unit –II

- **Variations**
 - Types of variations
 - Causes of variations
 - Mutation rates and directions
- **Natural Selection:**
 - Types of selection
 - Selection forces
 - Experimental demonstration of Natural selection
 - Industrial melanism and polymorphism
 - Sexual selection
 - Selection and non adaptive character

Unit-III

- **Speciation**
 - Isolation and its types

- Gradual and abrupt
- Origin of higher categories
- **Distribution of Species**
 - Island, Ocean and Continental distribution
 - Theories of continental drift.
- **Extinction**
 - Kinds of extinction
 - Causes of extinction
 - Great extinctions

Unit-IV

- **Quantative and Molecular Aspects of Evolution**
 - Hardy- Weinberg law
 - Selection pressure
 - Mutation pressure
 - Genetic drift
 - Migration
 - Meiotic drive
 - Brief account:
 - Evolution of genome in viruses, prokaryotes and eukaryotes
 - Molecular clocks
 - Future Course of Evolution

Suggested Reading Material

1. Avers, C. J.(1989). Evolution Process and Pattern in Evolution Oxford University, Press, New York, Oxfor.
2. Ayala, F. J. and Valentine J. W. (1979). Evolving the theory and Process of Organic Evolution, Benjamin Cumming.
3. Brookfield, A. P. (1986). Modern aspects of Evolution. Hutchinson London, Melbourne.
4. Gallow, P. (1983). Evolutionary principles. Chapman and Hall.
5. Freeman, S. and Herron, Jon C. (2007). Evolutionary analysis Pearson Prentice Hall, New Jersey.
6. Futuyma, D. J. (1998), Evolutionary Biology, Sinauer Assoc. Inc. Pub. USA.
7. Meglitsch, P. A. (1991), Invertebrate Zoology (3rd edition), Oxford University Press.
8. Minkoff, E. C. (1983), Evolutionary Biology, Addison Wesley Pub. Co., London.
9. Wen-Hsiung Li (1997), Molecular Evolution, Sinauer associates Inc.Pub. USA.

Semester-II
ZooC-604: Seminar/ Project

Maximum Marks: 50

Instructions:

The students are required to present a seminar on a topic of relevance and importance from the subject of Zoology or carry out research project on the assigned topic and present a seminar. The seminar carries 50 marks (10 for material, 15 for presentation, 5 for discussion and 20 for the seminar based paper at the end of the semester).

Semester-II
ZooC-605: BIOSTATISTICS

Examination Time: 3 hrs.
Periods/Week: 6

Theory: 37
Internal assessment: 13
Total Marks: 50

Note: The question paper will be set as per the pattern given below:

Section A: (Very short answer-type) It will consist of 7 questions. All are compulsory. Each question carries 1 mark (Total 07 marks).

Section B: (Short answer-type) The candidate will be required to attempt any 6 questions out of the given 10 questions. Each question carries 3 marks. (Total 18 marks).

Section C: (Essay type) The candidates will be required to attempt any 2 questions out of the given four questions. Each question carries 6 marks. (Total 12 marks).

UNIT-I

• **Elementary Statistics**

Representation of data- discrete data, continuous data, histogram, polygons, frequency curves. The mean Variability of data, Standard deviation. Median, Quantiles, Percentile, Skewness, Box and whisker diagrams (box plots), Introduction to statistical sampling from a population, Random Sampling.

UNIT-II

• **Probability**

Experimental Probability, Probability when outcomes are equally likely, Subjective Probabilities, Probability laws Probability rules for Combined events, Conditional Probability and Independent Events, Probability trees, Bayes theorem. Probability Distribution Bernoulli Distribution, Binomial Distribution Poisson Distribution Uniform Distribution Normal Distribution, Normal approximation to binomial distribution, Central limit theorem.

UNIT-III

• **Multivariate Analysis**

Regression and correlation:, Correlation & Regression, Scatter diagram, Regression function, Linear correlation and regression lines, Product moment correlation coefficient. Cluster analysis: Basics (Tree clustering), Distance Measures, Hierarchical tree, linkage rules (single and complete linkage, UPGMA), Two-way joining, k-means clustering and interpretation of results, expectation maximization. Principal Component Analysis (PCA): Principles and Applications to real life data.

UNIT-IV

Random Variables Discrete and continuous Random variables Cumulative distribution function, Probability Mass function, Probability Density Function Expectation of random variables experimental approach and theoretical approach. Expectation of X and variance of X, Expectation of function $E[g(X)]$. Hypothesis Testing: Fischer test, Chi Square test, Student ttest, ANOVA in reference to experimental design.

Suggested Reading Material:

1. Batschelet, Mathematics for Life Sciences
2. Hussain I. et. al. Mathematics, A textbook for class XI, NCERT.
3. Joshi, D.D. et. al. Mathematics, A textbook for class XII, NCERT.

4. S. Sokal, R. and James F. Introduction to Biostatistics.

Semester-II

ZooC-651: PRACTICAL –III (FUNCTIONAL ORGANIZATIONS OF ANIMALS-II)

Examination Time: 4 hrs
Periods/Week: 4

Practical: 37
Internal Assessment: 13
Total Marks: 50

1. Study of permanent slides:
 - Skin of fish, frog, lizard, bird and mammal.
 - Setae of earthworm
 - Spicules of Sponges and Herdmania.
 - Internal ear of fish
 - Tentorium of grasshopper
 - Muscle fibers, cartilage and bone.
 - Endocrine glands of vertebrates.

2. Appendicular skeleton.

3. Study the following with the help of charts/models/videos/permanent slides.
 - Appendages of Prawn
 - Wing venation, coupling and types of wings of insects.
 - Comparative anatomy of nervous system in Earthworm, Cockroach, Pila, Sepia, Fishes, Bird and Mammal.
 - Eye muscles of fish/mammal
 - Modification of antenna in arthropods

*Minor changes in practical syllabus can be there as per the availability of materials.

**Dissections should be done in accordance with the UGC guidelines and after getting approved from the Dissection monitoring committee of the respective institution.

Semester-II

ZooC-652: PRACTICAL IV (EVOLUTION AND APPLIED ZOOLOGY-I)

Examination Time: 4 hrs

Periods/Week: 4

Practical: 37

Internal Assessment: 13

Total Marks: 50

1. Calculations for regression, correlation and variance of gene frequency and genetic equilibrium (taking pea pods).
2. Examination of principle of natural selection as a process related to evolution in a population (using colored marbles / beads).
3. Comparison of skeleton for listing evolutionary trends.
4. Comparison of molluscan shells to depict polyphyletic origin.
5. Comparison of homologous and analogous structures (e.g. insect antenna, legs, limbs of vertebrate etc.).
6. Demonstration of kinds of mimicry in various groups of animals.
7. Mapping of geographic distribution of some birds, insects, fish etc.
8. Study of various evolutionary phenomenon using slides / photographs.
9. Study of fossils.
10. Preparation of Phylogenetic tree using some Priory weight characters with the help of 8 – 10 animals from various categories.
11. Physico-chemical analysis of honey.
12. Physico-chemical analysis of vermicompost.
13. Study of various qualities of lac.
14. Visit to apiary/vermicomposting unit/ sericulture unit/ Prawn Farm and preparation of report

* Minor changes in the practical syllabus can be done as per availability of the material.

Semester-III
ZooC-701: RESEARCH TECHNIQUES

Examination Time: 3 hrs.
Periods/Week: 8

Theory: 75
Internal Assessment: 25
Total Marks: 100

Instructions to the Paper setters:

The question paper will be divided into 2 sections.

Section A: (Total weightage 15 marks). This section will have 10 very short answer type questions. All questions will be compulsory. Each question will carry 1.5 marks. Questions are to cover the whole of syllabus.

Section B: (Total weightage 60 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 15 marks and its answers should not exceed 6 pages. The questions should not have more than two subparts.

Unit-I

- **Centrifugation**
 - Basic principles, theory and applications of preparative and analytical centrifugation
 - Rotor types, sedimentation coefficient and care of rotors
- **Chromatography**
 - Theory, principle and application of column, paper, thin layer, ion-exchange affinity chromatography, GLC, HPLC and FPLC

Unit-II

- **Spectroscopy**
 - Lambert Beer's law, theory & principles of single and double beam UV/Visible spectroscopy
 - Principle of NMR, ESR, Mass spectroscopy and their application in biology for qualitative and quantitative determination of biomolecules
 - Introduction to fluorescence spectroscopy and IR spectroscopy

Unit-III

- **Electrophoresis**
 - Theory and application SDS-PAGE and Agarose Gel electrophoresis
 - Introduction to IEF, (Iso-electric focusing) 2-D gel and capillary electrophoresis
 - Applications in biology for isolation of biomolecules based on charge and molecular weight
- **Introduction to gene amplification techniques**

Unit-IV

- **Radioisotopic Techniques**
 - Basic concepts of radioisotopy
 - Theory and applications of Geiger- Muller tube, solid and liquid scintillation counters, primary and secondary fluors
 - Safety rules for radioisotopic studies
 - Biological applications

Suggested readings:

1. Freifelder, D(1982). Physical Biochemistry, Application to Biochemistry and Molecular Biology, 2nd edition, W.H. Freeman & Company, San Fransisco.
2. Sawhney, S.K. and Singh, R. (2001). Introductory Practical Biochemistry, Narosa Publishing House, New Delhi
3. Slater, R.J. (1990). Radioisotopes in Biology- A Practical Approach, Oxford University Press, NY.
4. Tinoco Kenneth Saur and J.C. Wang. Physical Chemistry: Principles and Applications in Biological Sciences, 3rd edition.
5. Wilson, K and Goulding, K.H. (1991). Biologist's Guide to Principles and Techniques of Practical Biochemistry. 3rd., Edward Arnold, London.

Semester-III
ZooC-702: DEVELOPMENTAL BIOLOGY

Examination Time: 3 hrs.
Periods/Week: 8

Theory: 75
Internal Assessment: 25
Total Marks: 100

Instructions to the Paper setters:

The question paper will be divided into 2 sections.

Section A: (Total weightage 15 marks). This section will have 10 very short answer type questions. All questions will be compulsory. Each question will carry 1.5 marks. Questions are to cover the whole of syllabus.

Section B: (Total weightage 60 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 15 marks and its answers should not exceed 6 pages. The questions should not have more than two subparts.

Unit – I

- **Gametogenesis and Fertilization**
 - Spermatogenesis and oogenesis, vitellogenesis
 - Egg and sperm interaction, fertilization
 - Natural and artificial parthenogenesis.
 - In vitro fertilization and embryo transplantation.

Unit – II

- **Cleavage, Gastrulation & Differentiation**
 - Cleavage and its patterns
 - Biochemical changes during cleavage, influence of male and female pronuclei during early development
 - What determines cleavage pattern
 - Gastrulation and morphogenetic movements
 - Morphogenesis of germ layers
 - Morphogenetic field
 - Differentiation
 - Determination
 - Transdetermination

Unit – III

- **Induction and Maturation**
 - Induction, organization, competence and inductive response, Hierarchies of induction, principles of reciprocal action

- Control of metamorphosis and morphophysiology of metamorphosis in insects and frog
- Regeneration in Platyhelminthes and Coelenterates
- Histomorphological changes in regeneration of
 - Tail in Amphibians and Reptiles
 - Limb in amphibians
 - Vertebrate lens
- Concept of growth at cellular, subcellular and organ level.

Unit – IV

- **Genetic Control of Development**

- Nuclear determination of developmental events.
- Molecular basis of early embryonic development.
- How is genetic control exercised during development.
- Influence of extrinsic factors on genetic control
- Nucleus and cytoplasmic interactions during development.

Suggested Readings:-

1. Balinsky, B.I. (1981). An Introduction to Embryology, Saunders, Philadelphia.
2. Bellairs, R. (1971). Development Processes in Higher Vertebrates, University of Miami Press, Miami.
3. Berrill, N.J. (1971): Developmental Biology. McGraw Hill, New Delhi.
4. Browder, L. Developmental Biology, a Comprehensive Synthesis Plenum, New York.
5. Dawnpart, Developmental Biology.
6. Ebert, J.D. & Sussex, IM. (1970): Interacting Systems in Development, Holt, Rinehart and Winston, New York.
7. Gilbert, F. (1985, 95 & 2000): Developmental Biology, Sinaur.
8. Goel, S.C. (1984): Principles and Animal Developmental Biology, Himalaya, Bombay.
9. Grant, P. (1978): Biology of Developing System.
10. Karp, G. & Berrill, M.J. (1981): Development. McGraw Hill, New Delhi.
11. Loomis, W.F. (1986) Developmental Biology Macmillan, New York.
12. Miller, W.A. (1997). Developmental Biology Springer Verlag, New York.
13. Oppenheimer, J.M. and Willer, B.H. (1964): Foundation of Experimental Embryology, Prentice-Hall, New Delhi.
14. Pritchard, D.J. (1986): Foundation of Development Genetics, Taylor and Francis, London.
15. Saunders, J.W. (1982): Developmental Biology, Patterns, Principles, Problems, MacMillan, New York.
16. Spratt, N.T. Jn. (1971): Developmental Biology, Wordsworth, Belmont, Co.
17. Waddington CH. (1966): Principles of Development and Differentiation. MacMillan, New York.

Semester-III

ZooC-703: GENERAL BIOCHEMISTRY

Examination Time: 3 hrs.
Periods/Week: 8

Theory: 75
Internal Assessment: 25
Total Marks: 100

Instructions to the Paper setters:

The question paper will be divided into 2 sections.

Section A: (Total weightage 15 marks). This section will have 10 very short answer type questions. All questions will be compulsory. Each question will carry 1.5 marks. Questions are to cover the whole of syllabus.

Section B: (Total weightage 60 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 15 marks and its answers should not exceed 6 pages. The questions should not have more than two subparts.

Unit – I

- **Biomolecules**
 - Biological fitness of organic compounds. Dimension and shape of biomolecules
 - Supramolecular structures and cell organelles
- **Water**
 - Physical properties and structure of water, hydrogen bonding
 - Solvent properties of water, ionization of water, fitness of aqueous environment for living organism
 - pH and buffers
- **Proteins**
 - Amino acids as building blocks of proteins, essential amino acids, non-protein amino acids, structure of peptide bond
 - Organizational levels of protein structure. Relationship between primary and higher order structures
 - Supramolecular assemblies of proteins
 - Solubility denaturation, functional diversity and species specificity of proteins, chemical synthesis and sequencing of polypeptides
 - Protein classification

Unit – II

- **Enzymes**
 - Catalytic specificity
 - Enzyme substrate complex, active sites
 - Michaelis – Menton kinetics, V_{max} and K_m and their significance
 - Reversible and Irreversible inhibition, Regulatory enzymes
- **Carbohydrates**
 - Definition, families of monosaccharides, structure of carbohydrates, stereoisomerism, trisaccharides and polysaccharides (starch, glycogen, cellulose, dextrans)
 - Sugars of bacterial cell wall

Unit – III

- **Lipids**
 - Definition and Classification of lipids
 - Fatty acids and essential fatty acids
 - General structure and functions of major lipid subclasses, acylglycerols, phosphoglycerides, Sphingolipids, terpenes, steroids and prostaglandins.
- **Biological membranes**
 - Common features, structural components, phospholipids, glycolipids and cholesterol.
 - Lipid bilayer and membrane proteins
 - Fluid mosaic model and membrane asymmetry
 - Transport across membranes.

Unit – IV

- **Generation and storage of metabolic energy-Bioenergetics of Metabolic Pathways:**
 - Glycolysis
 - Pentose phosphate pathway
 - Glyoxalate
 - Citric acid cycle
 - Oxidative phosphorylation
 - Gluconeogenesis
 - β oxidation of fatty acids
 - Biosynthesis of saturated fatty acids
 - General reactions and metabolism of amino acids.
- **Nucleic Acid Structure:**
 - Watson and Crick model of double DNA helix, synthesis of Nucleotides
 - Chemical Synthesis of Nucleic acid.

Suggested Reading Material:

1. Conn, E.E., Stump. P.K. Bruening, S. and Doi R.H. (1987) Outlines of Biochemistry 5th edition John Wiley and Sons Inc., New York.
2. Fischer, J. and Arriold, J.R.P. (2001). Instant notes in Chemistry for Biologists Viva Books Pvt. Ltd.
3. Harper, H.A. (2000): Harper's Biochemistry 25th ed.
4. Holde, K.E.V., Johnson, W.C. and Shing, P. (1998). Principles of Physical Biochemistry Prentice Hall, Inc., USA.
5. Lehninger, A (2000). Principles of Biochemistry. 3rd Edition. Kalyani Publishers.
6. Lehninger A.D. Nelson D.L. & Cox M.M. (1993) & (2000), Principles of Biochemistry, 2nd and 3rd ed. Worth Publishers, New York.
7. Morris, H. Best, L.R., Pattison, S., Arerna, S. (2001). Introduction to General Organic Biochemistry. 7th Ed. Wadsworth Group. Rawn, J.D. (1989). Biochemistry, Niel Patterson Publication U.S.A. North Carolina
8. Sheehon, D (2000). Physical Biochemistry: Principles and Applications – John Wiley & Sons Ltd., England.
9. Stryer, L. (1988). Biochemistry, 3rd edition San Francisco W.H. Freeman

Semester-III
ZooC-704: APPLIED ZOOLOGY-II (VERTEBRATES)

Examination Time: 3hrs.

Periods/Week: 6

Theory: 56

Internal Assessment: 19

Total Marks: 75

Instructions to the Paper setters:

The question paper will be divided into 2 sections.

Section A: (Total weightage 12 marks). This section will have 6 very short answer type questions. All questions will be compulsory. Each question will carry 2 marks. Questions are to cover the whole of syllabus.

Section B: (Total weightage 44 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 11 marks and its answers should not exceed 6 pages. The questions should not have more than two subparts.

Unit-I

- **Pisciculture**
 - Economically important fresh water and marine fishes
 - Fish culture: aims and evolution
 - Fish Farming Technologies
 - Factors affecting fish culture
 - Problems of seed collection from natural resources (in brief)
 - Induced breeding methods
 - Products and by products from pisciculture
- **Poultry**
 - Nomenclature and breeds of poultry birds
 - Poultry products
 - Egg structure and quality, nutritive values, abnormalities in eggs, factors affecting size and egg processing
 - Broilers, meat processing
 - Poultry Rearing / Farming
 - Nutritional Requirements
 - Housing and equipment
 - Poultry diseases
 - Poultry products and by products

Unit - II

- **Fur Industry**
 - Fur producing animals
 - Fur farming, dressing, processing and dyeing
 - Fur industry in India

- **Leather Industry**
 - Animals of leather industry
 - Processing of skin, flaying, Curing, salting and tanning
 - Enemies of skin industry

Unit-III

- **Dairy Farming**
 - Milching animals, Breeds, Housing and raising and Tools of management
 - Artificial insemination and IVF for improvement of stock
 - Milk composition and dairy products
- **Wool Industry**
 - Animals of wool industry
 - Types, structure and physicochemical properties of wool
 - Processing of wool: shearing, clearing, drying, bleaching, dyeing, spinning and twisting.

Unit -IV

- **Piggery**
 - Characteristics of swine and important breeds
 - Breed selection, management and housing; and nutritional needs
 - Products (Pork, Bristles, Lard, Sausages) and by products
 - Diseases of Pigs
- **Other Utilities of Animals**
 - Pharmaceuticals from animals (in brief)
 - Use of animals in vaccine production

Suggested Reading Material:-

1. Banarjee, G. C. (1982), Poultry. Oxford and IBH Pub. New Delhi
2. Banarjee, G. C. (1991), Text book of Animal Husbandry. Oxford and IBH Pub, New Delhi.
3. Jawal, P. L. (1977), Handbook of Animal Husbandry, I. C. A. R., Pub. New Delhi.
4. Jhingaran, V. G. (1991), Fish and Fisheries of India, Hindustan Pub. Co. India.
5. Khanna, S. S. (1986), An Introduction to Fishes, Central Book Depot, Allahabad.
6. Mustafa, S. (1990), Applied and Industrial Zoology, Rastogi publications, Meerut.
7. Sarkar, K. T. (1991), Theory and Practice of Leather manufacture. The Author, Madras.
8. Shami, Q. J. and Bhatnagar, S. (2002) Applied Fisheries . Agrobios India.
9. Shukla, G. S. & Upadhaya, V. B. (1991-92), Economic Zoology, Rastogi Publications, Meerut.
10. Srivastava, P. A. (1977), Economic Zoology, Commercial Publication Bureau, Kanpur.
11. Toor, H. S. and Kaur, K. (1996), Fish Culture Manual. PAU, Ludhiana.
12. Yadav, M. (2003) Economic Zoology, Discovery Publication House, New Delhi.

Semester-III

ZooC-751: PRACTICAL -V (RESEARCH TECHNIQUES & APPLIED ZOOLOGY-II)

Examination Time: 4 hrs
Periods/Week: 4

Practical: 37
Internal Assessment: 13
Total Marks: 50

I. Chromatography Techniques: (for separation of macromolecules)

1. Paper chromatography
2. Thin layer chromatography
3. Gel permeation chromatography

II. Spectrophotometric Techniques:

4. Preparation of standard curve of BSA, DNA, RNA
5. Measurement of the transmission of light through different solutions or substances at different wavelengths of light.
6. Estimation of DNA/RNA using teaching kits.

III. Electrophoresis Techniques:

7. Preparation of native polyacrylamide gel
8. Gel separation of proteins by native PAGE
9. Preparation of SDS-polyacrylamide gels
10. Separation of proteins by SDS-PAGE
11. Direct and Indirect ELISA

IV. Centrifugation:

12. Sedimentation using Swing out Rotor and Angle Rotor
13. Differential centrifugation.

V. Applied Zoology

14. Physico-chemical analysis of milk.
15. Study of different qualities of leather.
16. Study of different qualities of wool.
17. Visit to poultry/piggery/dairy/rabbit/sheep/fish farm/meat processing/leather industry/wool industry and preparation of report. The report shall carry 5 marks in the practical examination.

* Minor changes in the practical syllabus can be there as per availability of the live materials.

As per the latest UGC guidelines (D.O.No. F. 14-6/2014(CPP-II) dated 01-08-2014) the dissections should not be conducted. The guidelines on this issue are available on the UGC website:
www.ugc.ac.in

Semester-III

ZooC-752: PRACTICAL VI (DEVELOPMENTAL BIOLOGY AND BIOCHEMISTRY)

Examination Time: 4 hrs
Periods/Week: 4

Practical: 37
Internal Assessment: 13
Total Marks: 50

1. Study of different larval forms across the animal Kingdom using charts/models/videos.
2. Developmental stages of chick and frog through slides/charts.
3. Metamorphosis through charts/audio video means in frog and insect.
4. Study of Gametes through permanent slides
 - a) Spermatogenesis in rat/frog/grasshopper.
 - b) Study of testis (rat/frog/grasshopper).
 - c) Study of Ovary (rat/frog/grasshopper)
 - d) Oogenesis in rat / frog/fish
5. Quantitative analysis of proteins by Lowry/ Bradford method.
6. Estimation of Lipids.
7. Estimation of Carbohydrates.
8. Study of absorption spectra of coloured solutions.
9. To prepare a buffer solution.
10. Preparation of Titration curve of weak acids and strong base and calculations of pKa value

* Minor changes in the practical syllabus can be there as per availability of the live materials.

Semester-IV
ZooC-801: ANIMAL BEHAVIOUR AND WILDLIFE CONSERVATION

Examination Time: 3 hrs.
Periods/Week: 8

Theory: 75
Internal Assessment: 25
Total Marks: 100

Instructions to the Paper setters:

The question paper will be divided into 2 sections.

Section A: (Total weightage 15 marks). This section will have 10 very short answer type questions. All questions will be compulsory. Each question will carry 1.5 marks. Questions are to cover the whole of syllabus.

Section B: (Total weightage 60 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 15 marks and its answers should not exceed 6 pages. The questions should not have more than two subparts.

Unit - I

- **Introduction-** Ethology as a branch of biology
- **Classification of behavioral patterns**
Stereotyped behavior (orientation, reflexes), Instincts vs. learnt behavior, , Imprinting
Analysis of behaviour (ethogram)
- **Neural and Hormonal Control of Behaviour**
- **Genetic and environmental components in the development of behaviour**
- **Communication:**
 - Chemical, Visual tactile and Audio communication
 - Functions of communication
 - Song specificity in birds
 - Evolution of language (primates)
 - Host-parasite relations

Unit-II

- **Social Behaviour**
 - Aggregations-schooling in fishes, flocking in birds, herding in mammals
 - Advantages and disadvantages of living in groups.
 - Group selection, kin selection, altruism, reciprocal altruism, inclusive fitness
 - Social organization in insects and primates
- **Reproductive Behaviour**
 - Evolution of sex
 - Mating and Courtship behaviour
 - Sperm competition
 - Sexual selection and Parental care

Learning and Memory

Conditioning (classical and operant), Habituation, Associative learning, Reasoning and Cognitive Skills

Unit – III

- **Wild life in India**
 - Wild life as resource and its value.
 - Causes of depletion of wildlife.
 - Wild life ecology, ecological sub regions, distribution of wildlife in India with particular reference to Himalayan regions, Peninsular India & Tropical rain Forest Regions

- Methods of studying wildlife and census of wildlife.
- National and state animals of India.
- Red data book, endangered, vulnerable, rare, threatened and intermediate species.
- Names, Organization and management of Wildlife sanctuaries, National parks, Biosphere reserve.
- **Wildlife Conservation**
 - Role of Zoos, parks and sanctuaries for conservation of some wild animals.
 - Laws, legislation and statutory bodies for protecting wildlife.
 - Measures for wildlife conservation.
 - Problems of wildlife management.

Unit – IV

- Status of Wildlife in Punjab
- Wildlife conservation and Human conflict
- **Special projects for Endangered Species and concerns:**
 - Project: Tiger
 - Project Hangul
 - Project Rhino
 - Project Elephant
 - Gir Lion Sanctuary Project
 - Project Great Indian Bustard
 - Crocodile breeding Project
 - Ecology & Conservation of the Himalayan Musk deer.
 - The Manipur Brow antlered deer

Suggested Reading Material:

1. Aggarwal, (2000), Wildlife of India.
2. Alcock, J. (1998), Animal behaviour, An evolutionary approach Sinauer Assoc., Sunderland, Mass, USA.
3. Drickamer, L. C. and Vessey, S. H. (1986), Animal Behaviour - Concepts, Processes and Methods. (2nd ed.), Wordsworth Publ. Co., California.
4. Giles, R. H. (1984), Wildlife Management Techniques, Natraj Publishers, Dehradun.
5. Gopal, R. (1992), Fundamental of Wildlife management Justice Home Allahabad.
6. Goodenough, J., McGurie and Wallace, R. A. (2001), Perspective on animal behaviour. John Wiley & Sons, Inc. New York.
7. Hosetti, B. B. (1997), Concepts in Wildlife Management, Chawla Press, Delhi.
8. Huntingford F. (1984), The study of animal Behaviour, Chapman and Hall, London.
9. Manning, A. (1979), An Introduction to Animal Behaviour, 3rd Edition. The English Language Book Society and Edward Arnold Publishers Ltd.
10. Manning, A. and Dawkins, M. S. (1992 & 1998), An Introduction to Animal Behaviour, 4th ed. (Cambridge low price editions). Cambridge University Press, Cambridge.
11. Negi, S. S. (1995), Hand Book of National Park, Sanctuaries and Biosphere Reservoirs in India, Indus publishing Co., New Delhi
12. Prater, S. H. (1980), The Book of Indian Animals, Bombay Natural History Society, Bombay.
13. Saharia, V. B. (1982), Wildlife in India, Natraj Publisher, Dehradun.
14. Sharma, B. D. (1994), High Altitude Wildlife of India, Oxford IBH, New Delhi.
15. Sharma, B.D. (1999), Indian Wild Life Resources Ecology and Development. Daya Publishing House, Delhi.
16. Sharma, B.D. (2002), Man environment and wildlife animal. IBH Publishing Co., Pvt. Ltd. New Delhi.
17. Teague, R. D. (1987), A manual of Wildlife Conservation, Natraj Publishers, Dehradun.
18. Tikadar, B. K. (1988), Threatened Animals of India, Publications of Zoological Survey of India, Calcutta.
19. Tirvedi, P.R. and Singh, U. K. (1996), Environmental Laws of Wildlife.

Semester-IV

ZooC-802: ANIMAL GENETICS & BIOTECHNOLOGY

Examination Time: 3 hrs.

Periods/Week: 8

Theory: 75

Internal Assessment: 25

Total Marks: 100

Instructions to the Paper setters:

The question paper will be divided into 2 sections.

Section A: (Total weightage 15 marks). This section will have 10 very short answer type questions. All questions will be compulsory. Each question will carry 1.5 marks. Questions are to cover the whole of syllabus.

Section B: (Total weightage 60 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 15 marks and its answers should not exceed 6 pages. The questions should not have more than two subparts.

Unit I

- **DNA-** The genetic material:
 - DNA: Structure, Properties, Replication and Packaging DNA into chromosomes
 - Prokaryote nucleoid structure.
 - Chemical composition of eukaryote chromosomes.
 - Euchromatin, Heterochromatin and banding pattern.
 - Repetitive DNA and sequence organization.
 - Protein synthesis
- **Linkage, Crossing over and Chromosome Mapping**
 - Cytological basis of crossing over.
 - Two factors crosses, Three factor crosses and interference.
 - Somatic Cell hybridization.

Unit II

- **Mutations**
 - Introduction and classification of mutation.
 - Molecular basis of mutation.
 - Radiation and chemical induced mutation
 - Correlation between mutagenicity and carcinogenicity.
 - Mutation Frequency.
 - Practical applications of Mutations.
- **Gene Concepts**
 - Classical versus molecular concepts of Gene.
 - Complementation test for functional allelism.
 - Regulation of gene expression in Prokaryotes and Eukaryotes.

Unit III

- **Bacterial Genetics**
 - Transformation, transduction and conjugation.
 - F mediated sex-duction.
 - Mechanism of recombination in bacteria.
 - Plasmid, Episome, IS elements and Transposons.
- **Genetics of Viruses**

- Organisation and expression of bacteriophage genomes
- Structure and infection cycles of viruses of eukaryotes
- Animal viruses and cancer.

Unit IV

- **Recombinant DNA technology**
 - Gene cloning and Sequencing.
 - Restriction endonuclease.
 - Vectors.
 - cDNA cloning.
 - Identification of Specific clone with a specific probe.
 - Techniques: Southern, Northern, Western Blotting, PAGE, PCR, DNA finger printing, DNA foot printing.
 - In situ hybridization, RFLP.
 - Practical applications of gene cloning.
- **Extranuclear inheritance**
 - Criteria for extranuclear inheritance
 - DNA and drug resistance.
 - Mitochondrial DNA and genetic diseases.
 - Mechanism of Sex determination, Sex differentiation, Sex linked inheritance.

Books Recommended:

1. Ayala, F.J. & Kiger, Jr. J.A. (1980) Modern Genetics. The Benjamin Cummings Publishing Co. Inc.
2. Brown T.A. (1992). Genetics- A Molecular Approach, 2nd ed. Van Nostrand Reinhold
3. De-Robertis, F.D.P. and De-Robertis Jr., E.M.E. (1987). Essentials of Cell and Molecular Biology, Saunders, Philadelphia.
4. De-Robertis, F.D.P. and De-Robertis Jr., E.M.E. (1987). Cell and Molecular Biology, Saunders, Philadelphia.
5. Freifelder, D. & Malacinski. G.M. (1993) : Essentials of Molecular Biology, Jones & Bartlett Publishers, Boston.
6. Gardener, E.J., Simmons, M.T.J. & Sunstad, D.P. (1999): Principles of Genetics, 8th ed. John Wiley & Sons, New York.
7. Miglani, G.S. (2000). Basic Genetics Narosa Publishing House, New Delhi.
8. Sambrook, J., Fritsch, E.F. and Maniatis, J. (1989). Molecular Cloning. A lab manual.
9. Satson, J.D. et. al. (1987) : Molecular Biology of Gene, 4th ed. Vol. I & II. The Benjamin / Cummings Publishing Co., Inc.
10. Winter, P.C., Hickey, G.I. and Fletcher, H.L. (1999) Instant notes in Genetics. New Delhi
11. Zubay. U.G. (1987), Genetics. The Cummings Publishing Co., Inc.

Semester-IV
ZooC-803: CONCEPTS OF IMMUNOLOGY

Examination Time: 3 hrs.
Periods/Week: 8

Theory: 75
Internal Assessment: 25
Total Marks: 100

Instructions to the Paper setters:

The question paper will be divided into 2 sections.

Section A: (Total weightage 15 marks). This section will have 10 very short answer type questions. All questions will be compulsory. Each question will carry 1.5 marks. Questions are to cover the whole of syllabus.

Section B: (Total weightage 60 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 15 marks and its answers should not exceed 6 pages. The questions should not have more than two subparts.

Unit-I

- **Introduction**
 - Types of immunity-innate and adaptive.
 - Features of immune response-memory, specificity and recognition of self and non-self.
 - Terminology and approaches to the study of immune system.
 - Immunity to viruses, bacteria, fungi and tumours.
- **Cells and Organs of the immune system**
 - Lymphoid cells, heterogeneity of lymphoid cells, T-cells, B-cells, Null cells, Monocytes, polymorphs
 - Primary and secondary lymphoid organs-thymus, Bursa of fabricius, spleen, lymph nodes, lymphatic system, Mucosa Associated Lymphoid Tissue (MALT)
 - Lymphocytes traffic.

Unit-II

- **Humoral Immunity:**
 - Antigen-antibody interactions, affinity and avidity, high and low affinity anti-bodies.
 - Immunoglobulins-classes and structure
 - Molecular mechanism of generation of antibody diversity.
 - Complement fixing antibodies and complement cascade.
- **Cell Mediated Immunity**
 - T-cell subset and surface markers
 - T-dependent and T-independent antigens
 - Recognition of antigens by T-cells and role of MHC; structure of T-cell antigen receptors

Unit-III

- **Immunological Disorders**
 - Types of Hypersensitivity reactions

- Autoimmune disorders, their underlying molecular mechanism, aetiology, diagnostic, prognostic and prophylactic aspects
- Immunodeficiency disorders; AIDS.
- **Immuno biotechnology: Hybridoma Technology**
 - Immunization of animals, isolation of stimulated spleen cells, Myeloma cell lines used as fusion partners. Fusion methods
 - Detection and applications of monoclonal antibodies,
 - Vaccines: conventional vaccines, Viral vaccines, Bacterial vaccines, peptide vaccines, genetically engineered vaccines
 - Production and application of lymphokines

Unit-IV

- **Immunodiagnostic Procedures**-Various types of Immunodiffusion and immunoelectrophoretic procedures-
 - Immunoblot
 - ELISA
 - RIA
 - Agglutination of pathogenic bacteria
 - Haemagglutination and inhibition.

Suggested readings:

1. Kuby, J., Immunology W. H. Freeman and Company, New York, (1992).
2. Paul, W.E., Fundamental Immunology, 2nd edition, Raven Press, New York. (1989).
3. Paul, W.E.: Immunology; recognition and response. W.H. Freeman, New York. (1991).
4. Playfair, J.H.L.: Immunology at a glance, 5th edition, Blackwell Scientific Publications, Oxford. (1992).
5. Roitt, I. M. Brostoff, J and Male, D., Immunology, 2nd edition, Gower Medical Publishing, New York. (1989).
6. Roitt, I. M., Essential Immunology, 6th edition, Blackwell Scientific Publications, Oxford. (1988).

Semester-IV
ZooC -804: BIOSYSTEMATICS

Examination Time: 3hrs.
Periods/Week: 4

Theory: 37
Internal Assessment: 13
Total Marks: 50

Instructions to the Paper setters:

The question paper will be divided into 2 sections.

Section A: (Total weightage 09 marks). This section will have 6 very short answer type questions. All questions will be compulsory. Each question will carry 1.5 marks. Questions are to cover the whole of syllabus.

Section B: (Total weightage 28 marks). This section will have eight questions, two questions from each unit. The student will have to attempt four questions, one from each unit. Each question will carry 07 marks and its answers should not exceed 6 pages. The questions should not have more than two subparts.

Unit-I

- **Introduction**
 - Terms / Definitions
 - History/Development of theories / kinds of classifications.
 - Importance of Biosystematics
 - Material basis of Biosystematics
- **Different attributes or evidences**
 - Character kinds
 - Character weighing
- **New aspects of Biosystematics**
 - Cytotaxonomy
 - Chemotaxonomy
 - Molecular taxonomy

Unit-II

- **Taxonomic Procedures**
 - Taxonomic collections
 - Preservation
 - Identification
 - Taxonomic keys (Different kind, salient features, merits and demerits)
- International Code of Zoological Nomenclature
- Nomenclature Principles, important rules, their interpretation and application in the scientific nomenclature.

Unit –III

- **Taxonomic Publications**
 - The Scientific publications
 - Systematic publications
 - Contents of publications
- **Taxonomic Hierarchy**
 - Species category and various concepts of species; Subspecies and other sub specific categories; Decision at species and sub species level
 - Hierarchy of categories- Lower and higher categories

Unit-IV

- History of kingdom systems
- Resume of Whittaker's system and other recent systems of classification
- An outline of classification of kingdom Animalia
- Salient features of minor phyla.

Suggested Reading Material:

1. Gote, H.E. (1982), Animal Taxonomy, Edward Arnold.
2. Jaffery, C. (1973), Biological Nomenclature, Edward Arnold.
3. Kapoor, V.C. (1987), Theory and Practice of Animal Taxonomy, IPH Pb. New Delhi.
4. Kitching, I.J., Forey, P.L. Humpherries, C.J. & William, D. 1998. Cladistics: Theory and Practice of Parsimony Analysis, Oxford University Press.
5. Mayer, E. (1969), Principle of Systematic Zoology, McGraw Hill Book Co. London.
6. Mayer, E. & Aschhok (1991), Principles of Systematics, McGraw Hill Book Co. London.
7. Minell, A. (1993), Biological Systematics, The State of Art. Chapman & Hall, London.
8. Quicke, D.L.J, (1996), Principles & Techniques of Contemporary Taxonomy, Blacky Academic & Professional, London, New York, Madras.
9. Sebu, Randall T. 2000, Biological Systematics: Principles & Applications Cornell University Press 256 pp.
10. Winston, J. 1999. Describing Species Practical Taxonomic Procedure of Biologists. Columbia University Press, Lincoln, R.J. Dictionary of Ecology, Evolution and Systematics.

Semester-IV

ZooC -851: PRACTICAL VII (BEHAVIOUR AND WILD LIFE)

Examination Time: 4 hrs

Periods/Week: 4

Practical: 37

Internal Assessment: 13

Total Marks: 50

1. To study the influence of temperature on development and population built up of *Tribolium/Rhizopertha/Callosobruchus*.
2. To study the food preference in different animals.
 - a) *Tribolium/Rhizopertha*
 - b) *Pieris brassicae*.
3. To investigate the locomotive, explorative, withdrawal and habituation behaviours in Earthworm/Slug
4. To study the latent and operant learning in rat.
5. To study the thigmotaxis response in *Callosobruchus/ Tribolium/ Rhizopertha*
6. To study the Geotaxis Responses in
 - a) *Tribolium*
 - b) Ant
 - c) *Pieris brassicae* Larvae
 - d) Slug
7. To study the Humidity Preference in
 - a) *Drosophila / Zaprionus*
 - b) *Tribolium*
 - c) *Callosobruchus*
 - d) *Pieris brassicae* Larvae
8. To study the Phototaxis to Point Source and Different Colours of Light.
 - a) Earthworm
 - b) *Zaprionus*
 - c) *Tribolium*
 - d) *Callosobruchus*
 - e) *Pieris brassicae* Larvae
9. Use of videos to study the
 - a) Grooming and righting behaviour in cockroach.
 - b) Tarsal response in butterfly/housefly.
 - c) Equilibrium study on housefly.
 - d) Effect of temperature on opercular movement in fish
10. To Investigate the Chemosensory Responses in *Zaprionus / Bactrocera*.
11. Study of body rhythms in human beings.
12. Study of animal behaviour patterns using photographs.
13. Wildlife project as assignment.

* Minor changes in the practical syllabus can be done as per availability of the live materials.

As per the latest UGC guidelines (D.O.No. F. 14-6/2014(CPP-II) dated 01-08-2014) the dissections should not be conducted. The guidelines on this issue are available on the UGC website: www.ugc.ac.in

Semester-IV

ZooC -852: PRACTICAL VIII (GENETICS AND BIOSYSTEMATICS)

Examination Time: 4 hrs
Periods/Week: 4

Practical: 37
Internal Assessment: 13
Total Marks: 50

1. To prepare and study the karyotype of human cell from meta phase pictures
2. To study the pedigree analysis of family.
3. To study blood groups in human beings.
4. Demonstration of Barr body in the oral epithelium of human beings.
5. To study different stages of mitosis in root tips of *Allium cepa*.
6. To study permanent slides of:
 - Mitosis in bone marrow cells of rat.
 - Stages of meiosis in testis of rat/grasshopper/*Allium cepa*.
 - Polytene chromosomes in third instar larvae of *Zaprionus paravittiger*
7. To study dermatoglyphics with palms of hands and fingertips.
8. To study inheritance of morphogenetic human characters.
9. Isolation of DNA from plant tissues.
10. Numericals on Mendelian laws of inheritance and Linkage.
11. Serum extraction from blood.
12. ELISA & RIA Rocket Immuno- electrophoresis.
13. Demonstration of various kinds of equipment required for collection and preservation of animals.
14. Videos of Methods of collection and preservation.
15. Kinds of keys and their use at higher and lower category levels.

*** Minor changes in the practical syllabus can be done as per availability of the live material.**

As per the latest UGC guidelines (D.O.No. F. 14-6/2014(CPP-II) dated 01-08-2014) the dissections should not be conducted. The guidelines on this issue are available on the UGC website:

www.ugc.ac.in